

BIOSTIMULANTS AND THEIR IMPACT ON GROWTH AND FRUIT QUALITY OF POMEGRANATE TREES VIA FOLIAR SPRAY

Ahmed M.M. Abdelghany

Pomology Dept., Fac. of Agric., Assiut Univ., 71511 Assiut, Egypt.

*Corresponding Author: Ahmed.Abd_Elgany@agr.aun.edu.eg

ORCID: 0000-0002-5207-3661

Abstract:

A technique of agricultural management and production known as "clean agriculture" avoids or reduces the use of synthetic fertilizers and pesticides, thereby reducing air, soil, and water pollution. In order to achieve this, during the two succeeding growing seasons of 2021 and 2022, a field experiment was conducted on Manfalouty and Hejazy pomegranate cultivars, grown in a loamy soil at 4*4 m apart under a surface irrigation system in the pomology department orchard, faculty of agriculture, Assiut university. Four foliar treatments using vermicompost (16.5 and 25 ml/ L water) and fish fertilizer (0.5 and 1.5 ml/ L water) at two times (at full bloom and a month after full bloom) were applied to fifteen trees of both cultivars. The results demonstrated that all used foliar fertilizers significantly enhanced vegetative, physical and chemical measurements, where fish fertilizer at 0.5 ml/ L recorded the best increment in leaf area. Moreover, fish fertilizer at 1.5 ml/ L recorded the best increase in fruit, arils, rind weight, juice volume, TSS/ acid while decreased acidity. Where vermicompost at 16.5 and 25 ml/L recorded the best increment in TSS and reducing sugars.

Keywords: Fish fertilizer, vermicompost, sustainable agriculture.

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Introduction:

Pomegranate (*Punica granatum*, L.), a specie of economically significant commercial fruit plant, is a member of the Pinaceae family. The plant tolerates drought well, is winter resistant, and does well in rainy environments. A good source of protein, carbohydrates, minerals, antioxidants, as well as vitamins A, B, and C. Pomegranates are also helpful in preventing diarrhea, hyperacidity, and Tuberculosis (TB).

In order to maintain and protect the environment, as well as increase the earth's natural resource base and sustainable agriculture practices reduce the use of pesticides. Sustainable agriculture has several objectives, including: Increasing lucrative agricultural income and fostering environmental responsibility.

The use of organic compound solutions as foliar fertilizer sprays is developing as a result of the high cost and risky consequences of chemical fertilizers. Current research efforts have concentrated on understanding vermicomposting applications and their effects on soil and plants (**Adhikary, 2012**).

The application of bio stimulants allowed a reduction in fertilizers without affecting yield and quality (**Bulgari et al., 2015**). However, bio stimulants are plant extracts and contain a wide range of bioactive compounds that are mostly still unknown (**Bulgari et al., 2015**). The development of plant bio stimulants has become the focus of much research interest. Plant bio stimulants are used to enhance plant growth (**Gul et al., 2014**).

According to **Edwards and Burrows (1988)**, vermicompost is a peat like substance created by a non-thermophilic process that involves the biodegradation and stability of organic materials through interactions between microorganisms and earthworms. It is made by earthworms and rich in macro- and micronutrients, growth hormones, enzymes like proteases, amylases, lipases, cellulose, and chitinase, as well as vitamins and immobilized microorganisms. The worms still degrade organic stuff

even after their enzymes are removed (**Barik *et al.*, 2011**). Its porosity, aeration, drainage, and water holding capability set it apart from other materials.

Vermicompost has been demonstrated to benefit a variety of crops, including field crops, ornamentals, legumes and grains, flowering plants, and vegetables (**Chan and Griffiths, 1988; Edwards and Burrows, 1988; Mba, 1996; Subler *et al.*, 1998; Atiyeh *et al.*, 2000**). Many nutrients, including N, P, K, Fe, Mg, Ca, Mn, Zn, S, B, and Cu can be found in vermicompost.

It enhances plant nutrition, photosynthesis, the amount of chlorophyll in the leaves, and the nutrient content of different plant parts (roots, shoots, and fruits). Because it encourages the synthesis of phenolic compounds like flavonoids and anthocyanins, which may enhance plant quality and serve as a disease and pest preventative, vermicompost includes an adequate amount of humic acid for plant health (**Theunissen *et al.*, 2010**).

The fish oil spraying was found to reduce fruit set, thus, it is considered as an efficient bloom thinner in Golden Delicious and Red Chief Delicious apple trees (**McArtney *et al.*, 2006 and David *et al.*, 2008**). Fish oil is a natural product composed of the fatty acid esters of glycerol as an alternative to synthetic fungicides and insecticides (**Osnaya and Schlöser, 1998**).

The findings by **Bidabadi *et al.* (2017)** suggested that Vermicompost leachate (VCL) might reduce the aggregation of Na and modify the activities of antioxidant enzymes, which would boost plant efficiency and mitigate the harm caused by salt stress in pomegranate. Moreover, vermicompost was reported to be used to either spray trees or be added to the soil by **Abdel Salam and Roshdy (2022)**. Both, Vermicompost leachate and vermicompost had a beneficial effect on fruits, but combining the two provided the best results.

Results of **Poozeshi *et al.* (2020)** showed that more measured parameters such as titratable acidity (TA), total soluble solids (TSS) were significantly impacted by 12.5 kg/ tree of V2H2Zn2 (Vermicompost).

Masoud and Abou-Zaid (2017) found that all fish oil treatments significantly improved the berry quality of “Ruby Seedless” grapevines in terms of increasing berry weight, total soluble solids %, reducing sugars % and skin berry anthocyanin as well as decreasing titratable acidity % compared to unsprayed ones.

Thus, the aim of this work was to evaluate the influence of vermicompost and fish fertilizer on yield and fruit quality of Manfalouty and Hejazy pomegranate cultivars under Assiut climatic conditions.

Materials and methods:

Experiment site:

The experiment was executed on 45 years-old, Manfalouty and Hejazy pomegranate cultivars grown in the research farm and laboratory of the pomology department, faculty of agriculture, Assiut University, Egypt, during the two successive seasons of 2021 and 2022.

Plant Materials

A complete randomized block design was used to select 30 healthy pomegranate trees from the two cultivars under study (15 trees for each cultivar, 3 trees per treatment).

1. Vermicompost (ORGANIC MAGIC) 16.5ml/ L. water
2. Vermicompost (ORGANIC MAGIC) 25 ml/ L. water
3. Fish fertilizer (SHETO FISH) 0.5 ml./ L. water
4. Fish fertilizer (SHETO FISH) 1.5 ml./ L. water
5. Control (water only)

A Knapsack sprayer was used to spray trees (20 L). Each tree might grow to its full potential with a total volume of 5 lit. The spraying solutions contained 0.5 ml/L of liquid soap, as a surfactant. Sprays were two times

during mid-May through full bloom and one month after full bloom spraying chemicals. Three trees (replicates) were included in each treatment, and recommended horticultural techniques like irrigation, soil management, and fertilization were carried out.

Vegetative measurement:

Leaf area (cm²) was measured by using the following equation as mentioned by **Ahmed and Morsy (1999)**

$$\text{Leaf area (cm}^2\text{)} = 0.41 (\text{Length of leaf} \times \text{Width of leaf}) + 1.83$$

Physical characteristics:

- 1- Fruit, arils and rind weights (g) were recorded by using sensitivity balance with 0.01g accuracy
- 2- Juice volume (ml) were determined by using a measuring cylinder

Chemical characters:

- 1- Total soluble solids (TSS %) was measured by using a hand refractometer (ATAGO N-IE).
- 2- Total acidity (T.A) expressed as % citric acid according to **A.O.A.C. (1984)**.

The total acidity was expressed as citric acid according to the following equation:

$$\text{Acidity (\%)} = \frac{\text{NaOH volume used in titration} \times \text{NaOH molarity} \times \text{equivalent weight of Citric acid}}{1000 \times \text{sample volume}} * 100$$

Where:

Equivalent weight of citric acid = 64
NaOH molarity = 0.1M
Sample Vol. = 5 ml.

- 3- TSS / acid ratio was also calculated.

- 4- Reducing sugars (%) were determined according to Lane and Eynon procedure outlined in **A.O.A.C. (1985)**.

Statistical analysis:

The study was designed as a randomized complete block design (RCBD) (5 treatments x 2 cultivars) with three replications for each treatment. The treatments were placed in a subplot, whereas the cultivars were placed in the whole plot. ANOVA was performed using Proc Mixed of the SAS software version 9.2 (**SAS, 2008**), and means were compared using the revised L.S.D. test at the 5% level of probability (**Steel and Torrie, 1980**).

Results:

1- Leaf area (cm²), fruit and arils weights (g):

Leaf area was significantly increased compared to the control (**Table 1**). Fish fertilizer (SHETO FISH) at 1.5 ml/L recorded the highest values of leaf area (cm²) of Manfalouty Pomegranate cultivar (12.60 and 11.46 cm²) compared to the check treatment, which recorded the lowest values (10.58 and 10.61 cm²) during 2021 and 2022 seasons, respectively.

For Hejazy cultivar, Fish fertilizer at 0.5 ml/L recorded the highest value (11.50 cm²) compared to the check treatment, which recorded the lowest value (10.99 cm²). Where Vermicompost (ORGANIC MAGIC) at 16.5 ml/L recorded the highest value (12.10 cm²) compared to the control, which recorded the lowest value (10.37 cm²) during both seasons, respectively.

These findings were the same trend found by **Abdel Salam and Roshdy (2022)** during the 1st season, where there was no significant difference during the 2nd season in this respect.

Fruit weight was significantly increased by all applied treatments compared to the control. Vermicompost (ORGANIC MAGIC) at 16.5 ml/L recorded the highest value of fruit weight of

Manfalouty cultivar (415.5 g) compared to the check treatment which recorded the lowest value (324.3 g) during the 1st season. Where spraying Fish fertilizer (SHETO FISH) at 1.5 ml/L recorded the highest value (376.8 g) compared to the check treatment, which gave the lowest value (321.7 g) during the 2nd season.

For the same respect, application of fish fertilizer (SHETO FISH) at 0.5 ml/L recorded the highest values for Hejazy cultivar (393.6 g) compared to the check treatment which gave the lowest value (329.4 g) during the 1st season, where the same fertilizer at 1.5 ml/L recorded the highest value (404.2 g) compared to the check treatment, which gave the lowest value (334.0 g) during the 2nd season.

Aril weight was also significantly increased by used treatments compared to the control. Vermicompost (ORGANIC MAGIC) at 25 ml/L recorded the highest value of arils weight of Manfalouty cultivar (271.0 g) compared to the check treatment, which recorded the lowest value (214.1 g) during the 1st season. Where spraying fish fertilizer (SHETO FISH) at 1.5 ml/L recorded the highest value (245.1 g) compared to the check treatment which gave the lowest value (210.8 g) during the 2nd season.

For the same respect, application of fish fertilizer (SHETO FISH) at 1.5 ml/L recorded the highest values for Hejazy cultivar (260.3 g) compared to the check treatment, which gave the lowest value (216.1 g) during the 1st season. Where vermicompost (ORGANIC MAGIC) at 25 ml/L recorded the highest value (264.1 g) compared to the check treatment which gave the lowest value (219.7 g) during the 2nd season.

Table (1): Effect of foliar application with biostimulants on leaf area, fruit weight and arils weight of “Manfalouty” and “Hejazy” Pomegranate trees during 2021 and 2022 seasons.

Treatments characteristics	leaf area (cm ²)				Fruit weight (g)				Arils weight (g)			
	Manfalouty		Hejazy		Manfalouty		Hejazy		Manfalouty		Hejazy	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Vermicompost (Organic Magic) 16.5 ml./ L. water	11.32	11.28	11.26	12.10	415.5	368.6	386.5	400.3	246.5	229.8	238.1	249.8
Vermicompost (Organic Magic) 25 ml./ L. water	11.89	11.20	11.45	11.70	371.2	370.6	382.2	392.7	271.0	243.1	250.4	264.1
Fish fertilizer (SHETO FISH) 0.5 ml./ L. water	11.77	11.46	11.50	11.84	369.9	357.5	393.6	393.9	244.1	232.9	236.9	251.9
Fish fertilizer (SHETO FISH) 1.5 ml./ L. water	12.60	11.24	11.32	11.26	366.1	376.8	386.4	404.2	251.1	245.1	260.3	256.6
Control (water only)	10.58	10.61	10.99	10.37	324.3	321.7	329.4	334.0	214.1	210.8	216.1	219.7
L.S.D 0.05	1.32	0.62	0.42	1.27	77.2	42.8	43.4	60.8	41.2	27.8	31.8	30.5



Fig. (1): Effect of foliar application with biostimulants on leaf area, fruit weight and arils weight of “Manfalouty” and “Hejazy” Pomegranate trees during 2021 and 2022 seasons.

2- Rind weight (g), juice volume (ml) and TSS (%):

Data in **Table (2)** indicated that **rind weight** was significantly increased by all used treatments compared to the control. Vermicompost (ORGANIC MAGIC) at 16.5 ml/L recorded the highest values of ring weight of Manfalouty cultivar (144.5 and 138.8 g) compared to the check treatment, which recorded the lowest values (110.2 and 110.9 g) during the two seasons, respectively. Whereas, spraying fish fertilizer (SHETO FISH) at 1.5 ml/L recorded the highest values (149.5 and 147.6 g) compared to the check treatment which gave the lowest values (113.3 and 114.3 g) for Hejazy cultivar during the two seasons, respectively.

For the respect of **juice volume**, the data indicated that juice volume was significantly increased by all used treatments compared to the control. Vermicompost (ORGANIC MAGIC) at 25 ml/L recorded the highest value for Manfalouty cultivar (233.3 ml) compared to the check treatment which gave the lowest value (197.2) during the 1st season, where Fish fertilizer (SHETO FISH) at 1.5 ml/L recorded the highest value (207.7 ml) compared to the check treatment which gave the lowest value (185.4) during the 2nd season.

In the same terms, application of Fish fertilizer (SHETO FISH) at 1.5 ml/L recorded the highest value for Hejazy cultivar (201.7 ml) compared to the check treatment, which gave the lowest value (190.7) during the 1st season. Where vermicompost (ORGANIC MAGIC) at 25 ml/L recorded the highest value (226.3 ml) compared to the check treatment, which gave the lowest value (196.6) during the 2nd season.

Likewise, **TSS** were significantly increased by treatments compared to the control. Fish fertilizer (SHETO FISH) at 1.5 ml/L recorded the highest value for Manfalouty cultivar (17.13 %) compared to the check treatment which gave the lowest value (16.72 %) during the 1st season. Where vermicompost (ORGANIC MAGIC) at 25 ml/L recorded the highest value (17.16 %) compared to the check treatment which gave the lowest value (16.70 %) during the 2nd season.

In the same regard, application of vermicompost (ORGANIC MAGIC) at 16.5 ml/L recorded the highest value for Hejazy cultivar (17.16 %) compared to the check treatment which gave the lowest value (16.72 %) during the 1st season. Furthermore, vermicompost (ORGANIC MAGIC) at 25 ml/L recorded the highest value (17.73 %) compared to the check treatment, which gave the lowest value (16.99 %) during the 2nd season.

These findings match those reported by **Poozeshi *et al.*, (2020)** and **Abdel Salam and Roshdy (2022)** during the 2nd season, where there was significant difference during the 1st season in this respect.

3- Acidity (%), TSS/acid and reducing sugars (%):

Data in **(Table 3)** showed that **acidity** was significantly decreased in all used treatments compared to the control. Fish fertilizer (SHETO FISH) at 0.5 ml/L recorded the lowest value for Manfalouty cultivar (0.39 %) compared to the check treatment which gave the highest value (0.62 %) during the 1st season, Fish fertilizer (SHETO FISH) at 1.5 ml/L recorded the lowest value (0.43 %) compared to the check treatment, which gave the highest value (0.65 %) during the 2nd season.

In the same respect, data took the same trend, where Fish fertilizer (SHETO FISH) at 0.5 ml/L recorded the lowest value for Hejazy cultivar (0.48 %) compared to the check treatment which gave the highest value (0.65 %) during the 1st season, where fish fertilizer (SHETO FISH) at 1.5 ml/L recorded the lowest value (0.44 %) compared to the check treatment, which gave the highest value (0.68 %) during the 2nd season.

These findings might be online with those reported by **Poozeshi *et al.*, (2020)** and **Abdel Salam and Roshdy (2022)** during the 1st season, where there was significant difference during the 2nd season in this respect.

Table (2): Effect of foliar application with biostimulants on rind weight, juice volume and TSS of “Manfalouty” and “Hejazy” Pomegranate trees during 2021 and 2022 seasons.

Treatments characteristics	Rind weight (g)				Juice volume (ml)				TSS (%)			
	Manfalouty		Hejazy		Manfalouty		Hejazy		Manfalouty		Hejazy	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Vermicompost (Organic Magic) 16.5 ml./ L. water	144.5	138.8	136.1	136.2	208.7	192.6	198.0	208.6	17.09	17.02	17.16	17.09
Vermicompost (Organic Magic) 25 ml./ L. water	124.7	127.5	144.1	142.9	233.3	197.7	208.2	226.3	17.11	17.16	17.09	17.73
Fish fertilizer (SHETO FISH) 0.5 ml./ L. water	118.8	124.6	133.3	142.0	207.7	196.8	197.3	209.3	16.98	17.07	17.09	17.31
Fish fertilizer (SHETO FISH) 1.5 ml./ L. water	122.0	131.7	149.5	147.6	224.9	207.7	210.7	210.8	17.13	16.98	17.07	17.22
Control (water only)	110.2	110.9	113.3	114.3	197.2	185.4	190.7	196.6	16.72	16.70	16.72	16.99
L.S.D 0.05	26.3	20.2	33.4	28.7	28.8	17.4	14.1	22.0	0.35	0.38	0.31	0.65



Fig. (2): Effect of foliar application with biostimulants on rind weight, juice volume and TSS of “Manfalouty” and “Hejazy” Pomegranate trees during 2021 and 2022 seasons.

TSS/acid ratio was significantly increased by the applied treatments as compared to the control and took the same trend of acidity, where fish fertilizer (SHETO FISH) at 0.5 ml/L recorded the highest value for Manfalouty cultivar (43.54) compared to the check treatment, which gave the lowest value (26.97) during the 1st season. Fish fertilizer (SHETO FISH) at 1.5 ml/L recorded the highest value (39.49) compared to the check treatment, which gave the lowest value (25.69) during the 2nd season.

In the same respect, fish fertilizer (SHETO FISH) at 0.5 ml/L recorded the highest value for Hejazy cultivar (35.60) compared to the check treatment, which gave the lowest value (25.72) during the 1st season. Fish fertilizer (SHETO FISH) at 1.5 ml/L recorded the highest value (39.14) compared to the check treatment, which gave the lowest value (24.99) during the 2nd season.

These findings were similar to those reported by **Abdel Salam and Roshdy (2022)** during the 1st season, where there was significant difference during the 2nd season in this respect.

Reducing sugars took the same trend of TSS and were also significantly increased in all used treatment compared to the control. Fish fertilizer (SHETO FISH) at 1.5 ml/L recorded the highest value for Manfalouty cultivar (10.11 %) compared to the check treatment, which gave the lowest value (9.49 %) during the 1st season. Vermicompost (ORGANIC MAGIC) at 25 ml/L recorded the highest value (10.13 %) compared to the check treatment, which gave the lowest value (9.47 %) during the 2nd season.

In the same regard, application of Vermicompost (ORGANIC MAGIC) at 16.5 ml/L recorded the highest value for Hejazy cultivar (10.13 %) compared to the check treatment, which gave the lowest value (9.49 %) during the 1st season. Moreover, Vermicompost (ORGANIC MAGIC) at 25 ml/L recorded the highest value (10.43 %) compared to the check treatment, which gave the lowest value (9.63 %) during the 2nd season.

The findings of TSS were in line with those reported by **Poozeshi et al., (2020)** and **Abdel Salam & Roshdy (2022)** during the 2st season, where there was significant difference during the 1st season in this respect.

Table (3): Effect of foliar application with biostimulants on acidity, TSS/ acid and reducing sugars of “Manfalouty” and “Hejazy” Pomegranate trees during 2021 and 2022 seasons.

Treatments characteristics	Acidity (%)				TSS/ acid				Reducing sugars (%)			
	Manfalouty		Hejazy		Manfalouty		Hejazy		Manfalouty		Hejazy	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Vermicompost (Organic Magic) 16.5 ml./ L. water	0.40	0.44	0.53	0.46	42.73	38.68	32.38	37.15	10.09	10.05	10.13	10.09
Vermicompost (Organic Magic) 25 ml./ L. water	0.44	0.45	0.50	0.49	38.89	38.13	34.18	36.18	10.10	10.13	10.09	10.43
Fish fertilizer (SHETO FISH) 0.5 ml./ L. water	0.39	0.46	0.48	0.47	43.54	37.11	35.60	36.83	10.03	10.08	10.09	10.21
Fish fertilizer (SHETO FISH) 1.5 ml./ L. water	0.45	0.43	0.54	0.44	38.07	39.49	31.61	39.14	10.11	10.03	10.08	10.16
Control (water only)	0.62	0.65	0.65	0.68	26.97	25.69	25.72	24.99	9.49	9.47	9.49	9.63
L.S.D 0.05	0.12	0.17	0.10	0.16	8.13	9.10	8.71	11.40	0.43	0.51	0.57	0.66

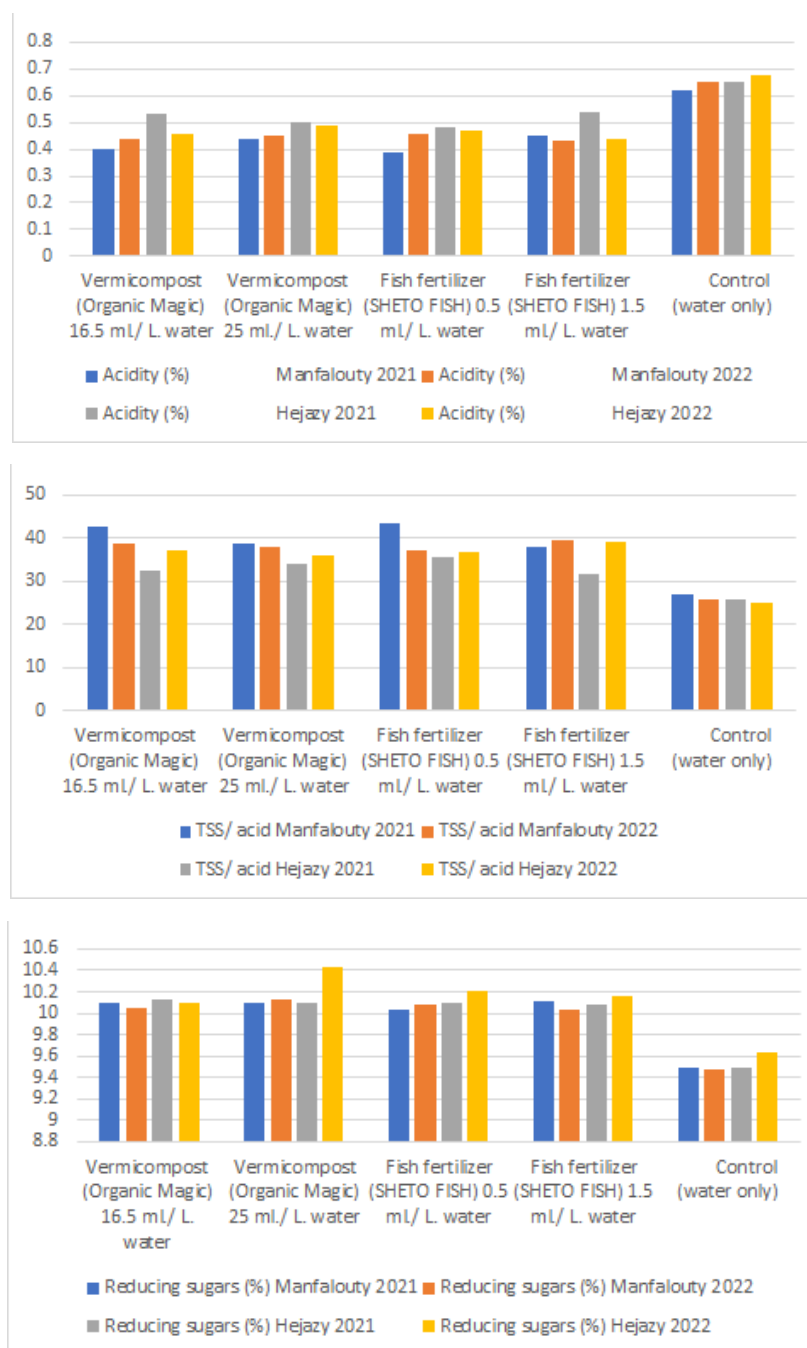


Fig. (3): Effect of foliar application with some biostimulants on acidity, TSS/ acid and reducing sugars of “Manfalouty” and “Hejazy” Pomegranate trees during 2021 and 2022 seasons.

Discussion:

Theunissen *et al.* (2010) noticed that vermicompost contains plant nutrients including N, P, K, Fe, Ca, Mg, S, B, Cu, Zn, and Mn that contribute to the nutrient content of different plant parts like roots, shoots, and fruits. Vermicompost tea contains living microbes that support plant development, nutrient uptake, and disease resistance (**Scheuerell and Mahaffee, 2002; Ingham, 2005; Hargreaves *et al.*, 2009**).

Therefore, it has been demonstrated that the use of a water-based vermicompost extract (vermicompost tea) can enhance crop output, plant health, and nutritional components in the plant (**Gamaley *et al.*, 2001 and Pant *et al.*, 2009**).

The hormones or high humate content of the vermicompost, along with a variety of plant nutrients, are most likely to blame (**Arancon *et al.*, 2004**).

Vermicompost altered the activity of several plant enzymes, including peroxidase, catalase, and others that promote cell elongation, root and shoot growth, and glucose metabolism in ber (*Zizyphus mauritiana* Lam.), according to **Choudhary (2016)**.

Vermicompost at higher doses, as well as improved availability of macro and micronutrients, growth hormones (auxin and gibberellins), vitamins, enzymes, humic acid, and beneficial bacteria to the crop plants (**Anitha *et al.*, 2003**).

During crop growth, the use of enhanced vermicomposts increased the availability of nutrients, which may have aided plant growth (**Nandi *et al.* 2013**).

Vermicompost's high content of macro- and micronutrients and strong capacity to absorb water led to improved photosynthesis (**Fathi *et al.* 2012**).

Vermicompost leachate (VCL) may significantly contribute to minimizing the harm that salinity causes to the chloroplasts by reducing chlorophyllase activity (**Chinsamy *et al.* 2013**).

Vermicompost application produced results comparable to those of inorganic fertilizer application, showing that vermicompost is a practical substitute for chemical fertilizer application (**Singh *et al.*, 2008**).

Fish amino acid (FAA) is good elements for plant growth and development and saves plant from stress since it works as natural fertilizer and medicine as well (**Chang *et al.*, 2014**).

Recommendation:

Therefore, it is recommended to spray fish extract at 1.5 ml/L and vermicompost at 25 ml/L at full bloom and a month after full-bloom to improve growth and fruiting of “Manfalouty” and “Hejazy” pomegranate trees under Assiut climatic conditions.

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المنشطات الحيوية وتأثيرها على تحسين النمو وجودة الثمار في أشجار الرمان عن طريق الرش الورقي

أحمد محمد محمد عبد الغنى

قسم الفاكهة، كلية الزراعة، جامعة أسيوط

الملخص العربي:

أجريت هذه الدراسة خلال موسمي 2021، 2022 بمزرعة الفاكهة، كلية الزراعة، جامعة أسيوط - بهدف دراسة تأثير رش تركيزين مختلفين من كمبوست الديدان (16.5 و 25 مل/لتر ماء) وسماد السمك (0.5 مل و 1 مل/ لتر ماء) على صنفى الرمان الحجازى والمنفلوطى عن طريق الرش مرتين: الأولى فى منتصف مايو (فترة التزهير الكامل)، والثانية بعد الرشة الأولى بشهر، حيث تم اختيار 15 شجرة متماثلة الصفات من كل صنف (إجمالي 30 شجرة).

أظهرت النتائج التي تم جمعها أن جميع الأسمدة الورقية المستخدمة أدت إلى تحسن كبير فى القياسات الخضرية والفيزيائية والكيميائية، حيث سجل السماد بمستخلص السمك بتركيز 0.5 مل / لتر أفضل زيادة فى مساحة الورقة. كما سجل السماد بمستخلص السمك عند 1.5 مل / لتر أفضل زيادة فى وزن الثمرة، الحبوب والقشرة وحجم عصير ونسبة المواد الصلبة الذائبة الكلية / نسبة الحموضة وخفض نسبة الحموضة، حيث أعطى كومبوست الديدان عند 16.5 و 25 مل / لتر أفضل زيادة فى المواد الصلبة الذائبة الكلية والسكريات المختزلة، وبالتالي يوصى برش مستخلص السمك بتركيز 1.5 مل/ لتر ومستخلص الديدان بتركيز 25 مل/ لتر عند التزهير الكامل وبعد التزهير الكامل بشهر لتحسين النمو والإثمار فى أشجار الرمان المنفلوطي والحجازي تحت ظروف أسيوط المناخية.

الكلمات المفتاحية: سماد السمك، كمبوست الديدان، الزراعة المستدامة.